Staff believes the most forward looking income tax rate for SWBT is the FIT and SIT Effective rate without ITC amortization. The reasons for this are:

1) ITC amortization is left over from 1987 and is being depleted. On a forward looking basis, ITC will be gone in the near future and SWBT will no longer be subject to it.

2) The Total Stat. Effective rate and FIT & SIT Effective without ITC amortization are converging. The difference between the two rates has decreased from 1.33 percent in 1991 to 0.03 percent in 1995. The difference has an insignificant impact in determining capital costs of unbundled elements.

Therefore, the income tax rate proposed by Staff is the FIT & SIT Effective Rate without ITC amortization of 38.36 percent.

Inflation Factors and Productivity Factors

Inflation Factors

SWBT includes two types of inflation in its cost models; Capital Investment Inflation and Operating Expense Inflation. Both factors are calculated using a levelization technique that uses the present value of future plant additions including inflation divided by the present value of the plant additions without inflation. In other words, the numerator of the equation is the present value of the future (inflated) cost of the plant additions while the denominator for this factor is the present value of future plant additions not including inflation during the contract period. For calculation purposes, the annual additions are always assumed to be one. The cost of money is used as the return for the present value calculations. SWBT uses this method to levelize the inflation factors throughout a contract period. By using a constant level of plant additions, this levelization method assumes the increase in network investment will always remain constant. Therefore, each yearly increase in cost as a result of inflation is weighted equally. In effect, this assumes the network will be fully replicated each year of the contract. In reality, the only part of the network that will realize an increase in costs is the amount replaced through the depreciation of part of the existing network and any new additions that occur through the growth of the network. In order to more accurately reflect the true effects of inflation, this factor should be calculated based upon the percentage of investment that is replaced or added to the network. Since Staff does not recommend the use of inflation in the cost models, the effects of the levelization technique were not explored further.

Capital Investment Inflation Factor (CLIF) - The purpose of this inflation factor is to recognize the increased cost of investment during the contract period. This is a levelized factor based upon the account specific Telephone Plant Index (TPI) forecast.

Operating Expense Inflation (OEInf) Factor - This inflation factor is intended to account for increases in the expense of operating and maintaining plant investment. Much of the increase in the operating cost is due to increases in the labor rate. Therefore, this rate is based upon the CPI - W which is the Consumer Price Index for Wages. Like the CLIF, this factor is also levelized using the cost of money.

Inflation and Productivity Factors

Staff is concerned with the use of inflation without the use of productivity factors. If the cost study is going to incorporate the increased cost of labor and capital, then the study should also incorporate the increased efficiency in employing those inputs.

SWBT included inflation factors in the cost study but did not include any type of productivity factor. Since inflation reflects the changes in material and labor costs over time it seems only reasonable to include a productivity factor which reflects changes in the efficiency of labor and material utilization. A chart of the sum of the TELCO Labor Factor and TELCO Engineering Factor for seven major accounts shows the labor and engineering expenses as a percentage of investment. In calculating these factors, neither the labor expense nor the level of investment is adjusted to remove the annual affects of inflation or productivity increases. If labor inflation were present while the productivity levels remained constant, the factors would appear to be increasing over time since labor expense per unit of investment would be increasing.

Of course the opposite is also true. If productivity increases were present but labor costs were remaining constant, labor expenses per unit of investment would be decreasing since less labor per unit of investment would be necessary. Comparing these seven factors over time shows no discernable trend that would indicate the presence of inflation without productivity improvements or only productivity improvements without inflation. Therefore, Staff believes that it is inappropriate to make an additional adjustment to include a single inflation factor or a single productivity factor without including both factors.

Summary of TELCO Labor and Engineering Factors
From 1991 - 1994

Account Category	1991	1992	1993	1994
2212 Electronic Digital Services	** __ **	** __ **	** __ **	** __ **
2220 Operator Services	** __ **	** __ **	** __ **	** __ **
2232 Circuit	** __ **	** __ **	** __ **	** __ **
2362 Other Terminal Equipment	** __ **	** __ **	** __ **	** __ **
2421.2 Aerial Cable - Metallic	** __ **	** __ **	** __ **	** __ **
2122.1 UG Cable Metallic	** __ **	** __ **	** __ **	** __ **
2422.2 UG Cable - NonMetallic	** __ **	** __ **	** __ **	** __ **

If both an inflation factors and a productivity factor were included in the studies, the net result would almost zero. For example, SWBT was including a 3-year levelized inflation factor of ** _____ ** for operating expenses while the Staff proposed productivity offset levelized over three years was ** ____ **.

The productivity factor originally proposed by Staff was 4.3% per year. This is based upon the price-cap productivity factor that SWBT agreed to on an interstate level. As additional support, data from a United States Telephone Association productivity study reflected a productivity gain of about 4% per year.

Given that the inflation factors and the productivity factors offset each other and the fact that the table fails to show a discernable trend, Staff recommends that neither a productivity offset nor an inflation factor be included.

SWBT argues that it is appropriate to include only an inflation factor in the cost studies. SWBT's reasoning is that by assuming the most efficient forward-looking technology, all productivity gains that a company might achieve have already been included in the cost studies. Staff disagrees with this because the operating and maintenance expenses included in the studies are based upon historic data from the current network and are not technology specific. Most of the operating and maintenance expenses are allocated to the forward-looking technology accounts based upon historic investment and do not reflect the maintenance expenses directly associated with the new technology. Because the factors are not specific to forward-looking technologies, they will not reflect the productivity gains associated with the new forward-looking technology. For this reason, Staff disagrees with SWBT.

Non-Recurring Charges for Unbundled Network Elements

Purpose of Non-Recurring Charges

The non-recurring charges (NRCs) proposed by SWBT are intended to recover the non-recurring or one time labor and expensed material costs associated with provisioning unbundled network elements (UNE).

Summary of Non-Recurring Charge Studies

The NRCs are intended to recover the expensed labor efforts required to provide UNEs to Competitive Local Exchange Companies (CLEC). SWBT proposes a NRC for almost every element available as well as an additional Service Order charge that applies to each element purchased. The NRC for a particular element includes both the installation and disconnection activity. It does not include the labor associated with maintaining or repairing the UNE.

Identifying non-recurring costs consists of:

- Identifying workgroups involved in the installation and disconnection for each element, Identifying the job functions required to perform the installation and disconnection of each work group,
- Identifying labor requirements within each work group, and
- Applying appropriate labor rates.

To identify the workgroups, subject matter experts determined what workgroups were involved in provisioning the service. Five workgroups were identified:

- Circuit Provisioning Center (CPC) -- provides circuit design and identifies necessary transmission equipment required to meet the circuit parameters.
- Procurement -- provides shipping of plug-ins from warehouse to central office and field locations.
- Central Office Forces (COF) -- installs plug-ins, wires and tests circuits through the central office(s).
- Installation and Maintenance (I&M) -- installs and tests services to the customer locations.
- Special Service Center (SSC) -- coordinates central office and I&M installation activity and performs remote testing.

Work functions are then grouped by unbundled element and totaled to arrive at the non-recurring cost per element. NRCs for all elements are calculated in this manner.

Concerns and Modifications for All Non-Recurring Charges

Staff has three major concerns with all remaining Non-Recurring Charges proposed by SWBT. Each of these is outlined below.

Source of Labor Estimates - The estimated labor time is based upon estimates provided by Subject Matter Experts (SMEs). At this time, SWBT has performed no Time and Motion Studies to support these estimates. As these are new functions, there is probably insufficient data to conduct these studies at this time. However, relying upon estimates from SMEs as the sole source of data is disturbing. NRCs involve a significant amount of expense and can be a significant barrier to entry for competitive companies entering the market. As the labor estimate is the primary input into the NRCs, its accuracy is of upmost importance.

Double Recovery of Labor Costs - Further compounding the labor issue is the fact that since this labor is expensed, it is included in the labor factors applied in the ACES model. SWBT defines the TELCO Plant Labor factors as the "labor cost for the telephone company to install the equipment" and the TELCO Engineering factor as the "labor cost for telephone engineers to design and engineer the equipment".[5] As these two factors are based upon the average labor for the three prior years, they include the average labor costs necessary to install and provision equipment for an average workload. However, the entry of CLECs is likely to increase the amount and type of work required by SWBT. Therefore, while a portion of the non-recurring labor costs are reflected in these factors, not all of the labor costs can be expected to be recovered through these factors.

Barrier to Entry & Market Entry Incentives - The final issue for consideration is the incentive created by the presence of large NRCs for UNEs compared to the low NRC associated with a simple CLEC conversion of all elements. The simple CLEC conversion (Simple Conversion) NRC recovers the non-recurring labor cost required when a CLEC purchases and combines all the elements necessary to provide local service. In this case, no TELCO engineering or labor is required. It is simply a computer records change. In this instance, the company would only pay $21.60[6] or no charge[7]. depending upon which charge is adopted by the Commission. If a CLEC were to provide its own switch but purchase an 8db loop and a 2-wire cross-connect from SWBT it would pay minimum non-recurring charges of $124.40 in addition to the collocation charges necessary to house its own equipment. This obviously creates the incentive for CLECs to purchase and combine UNEs from SWBT and not provide their own facilities. This incentive creates a great deal of concern regarding the development of facilities-based competition. Staff is not

---

5

MO Factors Binder, Provided to Staff by Southwestern Bell Telephone Company, 2/12/97, pages 9 - 10.

6 SWBT's Proposed Non-Recurring Charge. The Service Order Charge would also apply.

7 Staff's Proposed Non-Recurring Charge. The Service Order Charge would also apply.

suggesting the cost of NRCs be set solely based upon the incentives they create. Staff does believe that is an important consideration when considering the validity of the information presented by each party and affect these charges will have on the development of competition.

Concerns and Proposed Modifications to Specific NRCs

Service Order Charge - This is a NRC that is applied each time a CLEC orders an UNE. SWBT's proposed charge is $25.80 and assumes all orders are done manually and require approximately **__** minutes of labor to complete the ordering process. Like all NRCs, the required labor is based upon a SME's estimate. SWBT acknowledged that, in the near future, the ordering could take place electronically, but stated that it had no cost information for the electronic ordering of UNEs.

Given that no data about electronic ordering cost is available, Staff recommends that SWBT's current Primary Interexchange Carrier (PIC) charge of $5.00 apply. This is the fee SWBT applies to Interexchange Carriers (IXC) for switching a customer from one carrier to another. The process used to switch customers is electronic and should be similar to the service order process for switching local customers.

Staff recommends that this charge apply to initial service orders for each customer only and should not apply to modifications to existing CLEC customers configuration. Staff believes that the NRCs associated with each element are comprehensive and no additional NRC should be applied for additional functionalities of that element. This rate is likely to be in excess of the cost of electronic ordering and should cover the costs of additional ordering. In addition, SWBT included **________** in Wholesale Marketing and Service Expense in the Common Costs which are applied to all network elements. Staff believes these two revenues sources should allow SWBT to recover the costs associated with additional orders. Staff recommends this be an interim rate that is in effect until SWBT can develop TELRIC studies for the electronic ordering of UNEs. This rate is likely to be in excess of the cost of electronic ordering and should be reviewed in the future.

CLEC Simple Conversion Charge - This charge is intended to recover the non-recurring costs incurred when a CLEC converts a SWBT customer using all network elements required to provision the service. SWBT proposes a non-recurring charge of $21.85. Like SWBT's proposed Service Order Charge, this charge assumes a manual process that requires a SWBT marketing person **__** minutes to complete. The labor requirement is based upon a SMEs estimate. This charge also includes **__** for the data processing associated with the Service Order.

Staff recommends that there be no additional NRC for a CLEC Simple Conversion. The Staff proposed Service Order Charge of $5.00 would still apply. The expense associated with the Marketing Representative's **__** minutes of labor assumes a manual process and does not consider the fact the an electronic ordering system will be available in the near future. Also, many of the activities described in this NRC cost study are the same activities described in the NRC cost study for the Service Order Charge. When the time required for both the Service Order and Simple Conversion are combined, the result is **___** minutes to process the order. Staff does not believe that it is reasonable for a mechanical process to require **___** minutes to simply transfer one customer to another CLEC. Finally, is the issue of the Wholesale Marketing and Services expenses included in the Common Cost Allocator. Including Wholesale Marketing and Services expense in both the Common Cost Allocator and the NRCs will result in a double recovery and should not be allowed.

The issue of which company is responsible for identifying the types of services a customer has and which network elements are required to serve a customer was brought to our attention by SWBT. SWBT proposes that the CLECs ordering the UNEs through a Simple Conversion to be responsible for specifying which services the customer has and the elements that are necessary to serve that customer. SWBT contends that it does not want to be responsible for identifying which elements are required to serve a particular customer. The Commission's Arbitration Order permits "as is" customer changes but does not address the issue of specifying the necessary UNEs. The issue of "as is" customer changes was not an interim decision and was not addressed by Staff in this review. The issue of specifying which UNEs a particular customer requires was not specified in the Arbitration Order requiring the Staff Cost Study Review. However, Staff would like to bring this issue to the Commission's attention. Staff feels it would be appropriate to require the CLEC to specify exactly which elements it wishes to purchase. This would relieve SWBT from the duty and potential liability of making that determination.

Conclusion

Given that SWBT's estimation of these NRCs is based solely upon the opinions of SME's and the fact that at least a portion of these NRCs are recovered through the cost factors applied to the UNEs, Staff cannot recommend that the Commission accept the NRCs proposed by SWBT. Staff also cannot recommend the Commission accept AT&T/MCI's argument that 100 percent of the NRCs are reflected in the monthly UNE rates and there should be no NRCs. To the extent, the competitors create new or additional labor for SWBT, that labor will not be reflected in the historic cost factors. Staff believes there will be some additional NRCs associated with UNEs, but the extent of which is unknown.

Unfortunately, other than the $5.00 Service Order Charge and the CLEC Simple Conversion, Staff has no data to suggest an alternative that is based upon adequate data. Staff believes the issue becomes one of a burden of proof. If the burden of proof is upon SWBT to justify the proposed NRCs, Staff feels SWBT has failed. If the burden of proof is upon the competitor, Staff believes that AT&T and MCI have failed to provide a reasonable alternative.

The alternative that Staff proposes would be for the Commission to set the rates for the

NRCs at one-half of the rates proposed by SWBT. Given that neither party presents a

[redacted]

Common Cost Allocator

Purpose

The common cost allocator is used to assign the wholesale costs that cannot be attributed directly to a network element to the rate elements. These costs are generally considered overhead and administrative costs and include Executive and Planning Costs, General & Administrative Costs, and Wholesale Marketing Expenses. These costs are recovered by applying a percentage "mark-up" to the element costs.

The allocator is calculated by dividing the Forward-Looking Wholesale Common Costs by the Total Element Expenses. The allocator relies on published 1995 ARMIS data to identify the expenditures in the accounts considered to contain common costs. The 1996 ARMIS data was not available to use in this calculation.

Concerns and Proposed Modifications

Staff has no specific concerns or proposed modifications to this study other than Staff's proposed modifications affecting all studies (Cost of Money, Depreciation, etc.).

Summary

The common cost allocator has two primary components. The first component is the forward-looking common costs and the second is the unbundled element costs that are used in the denominator. Each component is described below.

Forward- Looking Common Costs - The common cost allocator uses an avoidable cost procedure similar to the one used in the retail calculation to determine the portion of retail and wholesale Marketing and Service Expenses. SWBT compares the Retail Marketing and Service Expenses to the Total Expense to calculate the Ratio of Retail Expenses to Total Expenses. This ratio is used to determine the amount of Wholesale Executive and Planning and General & Administrative expenses that are considered to be common costs for wholesale operations. Wholesale Marketing and Service Expense and Network Operations - Supervision Expense are added to the Wholesale Executive and Planning and General & Administrative expenses to arrive at the Wholesale Common Costs. Network Operations - Supervision is included because it is 4th level and above and is not included in any of the TELRIC studies. The Commission Assessment and Inflation Factors are added to the Wholesale Common Costs to arrive at the Total Forward-Looking Common Costs

Total Element Expenses - The Total Element Expenses are the expenses directly associated with the provisioning of unbundled elements. They are the Total Expenses minus the Retail and Wholesale Common Costs. Inflation Factors are added to the Total Elements Expenses to make them forward-looking. The same inflation factor is applied to both the numerator and the denominator so there is no net affect. The same would be true if a productivity factor were applied to both the numerator and the denominator.

Geographic Deaveraging

Geographic deaveraging is intended to make the interconnection rates more closely reflect the true economic costs which vary by geographic area. The FCC's Interconnection Order required State's to use a minimum of three geographic rate zones in setting the rates for interconnection. While this section has been stayed, Staff still proposes geographic deaveraging.

Proposed Modification

Staff proposes to deaverage by exchange into four geographic zones for all loop, switch port, and switching minute of use (MOU) and transport elements. The four zones are identical to SWBT's existing tariffed Rate Groups and are summarized in the following table.

Summary of Staff's Proposed Rate Zones

Zone	Rate Group	Description	Loop/Sq. Mile
1	D	Kansas City and St. Louis	**____**
2	C	Springfield	**____**
3	B	Suburban	**____**
4	A	Rural	**____**

Staff analyzed the loops per square mile which is a measurement of loop density and is a major unbundled network element (UNE) cost driver. The analysis indicated that each Rate Group is unique and should not be combined. The other major cost driver for loops is the loop length. SWBT stated that it did not have loop length by exchange or by Rate Group so this could not be reviewed.

SWBT originally proposed to deaverage all loops, MOU, and interoffice transport. Staff's review indicated that switch ports also vary by geographic zone and should also be geographically deaveraged.

SWBT's Position

The three geographic group proposed by SWBT are based upon a combination of the existing tariffed rate groups. The following table summarize those zones.

Summary of SWBT's Proposed Rate Zones

Zone	Rate Group	Description
1	C & D	Springfield, Kansas City, St. Louis
2	B	Suburban
3	A	Rural

SWBT chose three zones to comply with the minimum FCC requirements for geographic zones. The basis for the three zones was to simply combine the existing tariffed Rate Group C and D into one Zone and use the two remaining Rate Groups and Zones. SWBT offered no analysis to support the combination for Rate Group C and Rate Group D.

AT&T's Position

AT&T's Hatfield Model 3.1 proposed to deaverage by wire center based upon loop density zones. In many areas, a wire center is a smaller geographic area than an exchange. The Commission's Arbitration Order ordered interim geographic deaveraging by exchange and rejected the argument to deaverage by wire center. Staff still believes deaveraging by exchange is the best alternative.

The Hatfield Model

The Hatfield Model was initially developed by Hatfield Associates, Inc. of Boulder, Colorado, at the request of AT&T and MCI. Hatfield Model proponents consider the model to be based on Total Element Long Run Incremental Cost (TELRIC) principles. The model considers all costs to be variable and avoidable. In addition, the model attempts to use the most efficient forward-looking technology available. The model does not take into account any embedded investment or existing network considerations with the exception the model takes into account existing wire center locations. The model accommodates the allocation of overhead costs through the application of an overhead factor.

In brief, the Hatfield Model is a desktop computer model that builds a theoretical telecommunications network based on demographic, geographic, and geologic data. Investments to build the theoretical network are derived based on user definable prices for distribution, feeder, switching, and interoffice facilities. Capital costs are then applied to the investment for the components of the network. Costs for various unbundled network elements are then derived based on total or per unit bases.

Costs were developed based on AT&T/MCI inputs, SWBT inputs, and Staff inputs. The results may be found in the attachments at the end of the Hatfield Model summary. As expected, AT&T/MCI inputs yielded the lowest costs, while SWBT's inputs yielded the highest costs. Staff's inputs typically yielded costs somewhere in between.

The Hatfield Model attempts to determine forward looking TELRIC costs for unbundled telephone network elements. The Hatfield Model calculates costs of:

- Network interface device (NID)
- Loop distribution
- Loop concentrator/multiplexer
- Loop feeder
- End office switching
- Tandem Switching
- Common transport
- Dedicated transport
- Direct transport
- Signaling links
- Signal transfer points
- Service control points
- Operator systems

The model constructs an estimate of the pertinent costs based on customer demand, network component prices, operational costs, network operations criteria, and other factors affecting the costs of providing local service. From these data, the model builds an engineering model of a local exchange network with sufficient capacity to meet total demand, and to maintain a level of service. The model's inputs also include the prices of various network components, with their associated installation and placement costs, along with various capital cost parameters.

Based on these inputs the model calculates the required network investments by detailed plant category. It then determines the capital carrying cost of these investments, to which are added operations expenses to compute the total monthly cost of universal service, carrier access and interconnection, and various unbundled network elements, on both total cost and per unit bases.

The Hatfield Model is comprised of a set of data files, a distribution module, a feeder module, a switching and interoffice module, and an expense module. The distribution, feeder and switching/interoffice modules identify investment related to various facilities. The investment values are then plugged into the expense module where total and per unit monthly costs are derived.

Data Files

The Hatfield Model is dependent upon an extensive array of data files. The data is drawn from a variety of sources such as census reports, local telephone company ARMIS reports, Bellcore reports, and marketing surveys. A user has the ability to adjust 660 of these inputs. These input files contain information on demographics, geology, cabling/switching/facility costs, installation costs, wire center locations, subscriber usage, and customer line information. The model uses this information build a theoretical telephone network and based upon this network, the model estimates the investments and costs to provide various unbundled network elements.

A variety of different sources are used to identify different inputs. Hatfield Associates, Inc. has supplied default values based on its collective judgement, as augmented by subject matter experts, for such items as the price of varying cable sizes and labor costs. In many cases, the default values are specific to a company or a state. A Bellcore routing guide database is used to identify the location of existing wire centers, tandems and other switching centers. Company ARMIS reports are used to identify types of lines. Customer line information is based on 1995 census estimates of Census Block Groups (CBGs). The firm of PNR and Associates of Jenkintown, Pennsylvania utilizes census information to develop a database of demographic and geological parameters. PNR coded household street addresses and telephone numbers with latitude/longitude values and their census block codes. PNR estimates of residential lines are derived using 1995 CBG data from Claritas and current Donnelly Marketing household data. The household and census block data were geocoded and matched to corresponding wire centers based on NPA-NXX codes. Business line data were obtained from Standard Industry Codes (SIC) and then used in a business line estimation model to derive number of business lines. The business establishments were also geocoded. In addition to this data, data on unoccupied land in the CBG, bedrock depth, soil data, and water table depth are also recorded by CBG.

Distribution Module

The distribution module pertains to facilities extending from the customer's premise to the feeder cable. This module calculates the length and size of distribution cable (including poles and trenching), splices, drops and NIDs required to serve the specified number of customers in each CBG. The module accomplishes this task by drawing data from the data input files. The module then calculates the necessary investment for these elements.

The model determines the lengths and sizes of distribution cable, associated structures, terminals, splices, drops, and NIDs required to provide service to the number and type of consumers in each CBG, and the number and type of serving area interface and digital line carrier terminals required. The Hatfield Model chooses to serve a CBG using feeder facilities made of copper wires or digital line carrier over fiber beyond a user definable threshold to the CBG. Investment is calculated based on these characteristics and expense data. Additional considerations and assumptions are as follows:

- CGBs are square, divided into four quadrants, and each CBG is served by one wire center.
- If more than 50 percent of the CBG is empty, consumers occupy only two diagonally opposed quadrants of a CBG. Otherwise, consumers occupy all four quadrants. Each quadrant's occupied area is reduced uniformly, so that each quadrant is identical. The Hatfield Model accounts for high rises by the line density in the CBG and total area of the CBG.
- The Hatfield Model assumes a grid topology for distribution. The backbone distribution cables begin at a serving area interface and branch to within one lot depth of the CBG boundary.
- If the longest distribution cable is greater than a user defined distance (18kft is the default value, while SWBT uses 15 kft for its Hatfield runs), the model assumes a fiber connecting cable and extends it to a digital line carrier remote terminal and serving area interface located at the center of each occupied area. As lengths of distribution increase, load coils are added, larger cable is used, and digital line carrier powering is increased. If the longest distribution cable is less than the threshold, copper cable is assumed.
- The Hatfield Model uses CBG data to determine the total distribution distances involved. It estimates the investment in distribution cable, supporting structures, terminals, splices, drops, NIDs, and serving area interfaces. User defined values to customize the network include cable fill factors; sharing of structure with other utilities; distribution of aerial, underground, and buried cable; material and installation costs; and demographic factors. The Hatfield Model selects the minimum cable size based on known available cable sizes, fill, and demographics.
- Serving area interface investment is calculated based on the number of distribution

lines required and the urban/non-urban characteristics of the CBG.

- Digital Loop Carrier investment is calculated based on the length of and type of feeder.
- Feeder runs greater than 9 kft (user definable), fiber is assumed. For these types of runs one of two types of digital line carrier is used: TR-303 digital line carrier or Low Density digital line carrier. If the number of lines is below a user defined threshold value, low density digital line carrier is used.
- Feeder distance calculations are done in the distribution module because the distribution module needs to know the total route length from the wire center to the serving area interface to determine whether total copper loop lengths will exceed the cooper/fiber cross-over length (18 kft).
- Feeder routes branch off from the wire center in four directions, with sub-feeder facilities branching off at right angles from the feeder. V and H coordinates are then used to determine CBG distance from the wire center, along with feeder and sub-feeder distances. If main feeder intersects a CBG, no sub-feeder is assumed.
- The total feeder plus sub-feeder distance for a CBG determines whether the CBG is served by fiber or copper. CBGs closer to the wire center require more capacity than further CBGs. The Hatfield Model accounts for this by tapering the feeder facilities as the distance to CBGs increases.

For both the distribution and feeder modules line density is an important input and structural sharing is a key assumption. Line density refers to the total number of subscriber access lines per square mile. Line density is a key input because it determines several other parameters such as fill factors and the mixture of underground, buried and aerial plant, drop distance, pole spacing, and so on. The structural sharing assumption suggests the telephone company will share some of its facilities such as poles and trenches with other utilities. For instance the same pole or trench might be used by another utility; therefore the model reduces certain investment amounts in order to account for this structural sharing.

Feeder Module

The feeder module analyzes the portion of the network that extends from the wire center to the serving area interface. Based on data plugged from the distribution module, the Hatfield Model determines the size and type of cables required to reach the serving area interfaces in each CBG and supporting structures. The Hatfield Model also determines characteristics of the digital line carrier equipment needed to serve the CBGs that cannot be served by copper feeder. Investment is then calculated based on these characteristics and expense data. Additional considerations are described below:

- The feeder module uses data on main feeder and sub-feeder from the distribution module to calculate investment in feeder plants. Main feeder cable sizes are a function of number of lines served in each CBG and the feeder fill factor for the CBGs.
- Sizing of copper sub-feeder cable for individual CBGs is a function of lines in the

CBG and the copper feeder fill factor. The model selects the smallest size of cable that meets the quotient of dividing the number of lines needed in the CBG by the fill factor. The number of optical fibers needed to serve a CBG is calculated as the number of digital line carrier remote terminals in the CBG times the number of strands per remote terminal (user definable). The Hatfield Model selects the minimum sized optical fiber cable size that meets or exceeds the required number of strands.

- Each segment in the main feeder is sized to serve all the CBGs located past the segment, accounting for tapering of the feeder to the farthest located CBGs.
- The fraction of aerial, buried, and underground plant may be set separately for all density ranges and for each cable type, copper or fiber. Based on these fractions, the distances, and the cost of structure, the feeder module calculates the investment in feeder structure.

Switching and Interoffice Module

The switching and interoffice module calculates end office switching, tandem switching, signaling and interoffice investment. Switch capacity is determined by the number of lines in the CBG served by the wire center along with a user- adjustable fill factor. A switching cost curve is applied to determine the required switching investment per line. The curve is primarily based on typical per-line prices paid by Bell Operating Companies, GTE and other independents as reported in the Northern Business Information publication "U.S., Central Office Equipment Market: 1995 Database." The curve is represented on the y axis by investment per line while the x axis identifies lines served by switch. In general, the smaller the switch the higher investment per line. Listed below are some details to the calculations made in this module:

- Inputs to this module include total line counts for each wire center, distances between switches, traffic assumptions, and distribution of total traffic among local intraoffice, local interoffice traffic, intraLATA traffic, interexchange access, and operator services. Many of these values are user definable. From PNR, line counts for the CBGs and interoffice distances are obtained.
- The Hatfield Model places at least one end office switch in each wire center. The model sizes the switch by adding up all the switched lines in the CBGs served by the wire center, applying a user-definable fill factor. The Hatfield Model checks the capacity based on busy hour call attempts by the mix of lines served by each switch to determine if the switch is line limited or processor time limited, and compares offered traffic with a user defined traffic capacity limit. If the capacity of the selected switch is exceeded, the model calculates investment for an additional switch. Once switch size is determined, the model calculates required investment per line accounting for economies of scale. Investment per line is calculated based on typical per line prices paid by Bell Operating Companies and GTE as reported in the Northern Business Information publication "U.S. Central Office Equipment Market: 1995 Database." A switching investment curve is then developed from these data. Investment ranges from $173 per line for less than 2,000 lines to about

$80 per line for 80,000 lines. A different set of costs are used for small companies. Wire center investments required to support end office and tandem switches are based on assumptions regarding the room size required to house a switch, construction costs, lot sizes, land acquisition costs and investment in power systems and distributing frames.

- Transport calculations are based on traffic and routing assumptions and total mix of access lines served by each switch. The Hatfield Model assumes that all interoffice facilities are a series of interconnected OC48 SONET fiber rings. The model provisions enough of these rings to support all interoffice circuit requirements. Offices that serve less than 5,000 lines are assumed to need lower capacity, less expensive technology. Once the amount of fiber cable is determined, the model determines the costs of installed cable and structure based on user definable inputs for cable costs, structure cost and configuration, mix of structure type, and sharing between feeder and interoffice facilities.
- Tandem and operator tandem switching investments are computed according to assumptions contained in an AT&T Capacity Cost Study. The investment calculation assigns a price for switch "common equipment," switching matrix and control structure, and adds to these amounts the investments in trunk interfaces. The Hatfield Model scales the investment in tandem switch common equipment according to the total number of tandem trunks computed for the study area.
- The Hatfield Model computes signaling link investment for Signal Transfer Point (STP) to end office and tandem "A links," "C links," between STPs in a mated pair, and D link segments assumed to be connecting the STPs of different carrier's networks. All links are assumed to be carried on the interoffice rings. The Hatfield Model always equips at least two signaling links per switch. Required SS7 message traffic is computed according to the call type and traffic assumptions of the CBG. Other data define the number and length of Transaction Capabilities Application Part (TCAP) messages required for database lookups, along with the percentage of calls requiring TCAP message generation. STP capacity is expressed as the total number of signaling links each STP mated pair can terminate. STP investment is expressed in terms of dollars of investment per transaction per second derived from calls requiring TCAP message generation, and the TCAP message rate in each LATA.
- Operator tandem and trunk requirements are based on a user defined operator traffic amount and on the overall trunk capacity. Operator positions are assumed to be based on current workstation technology.

Expense Module

The expense module calculates annual and monthly costs for unbundled network elements. The expense module takes investments determined by the distribution, feeder, and switching and interoffice modules. The module estimates the capital carrying costs associated with the investments. The capital carrying costs include such costs as depreciation, rate of return, taxes, and maintenance. Non-network related operating expenses are also determined such as customer operations expenses, general support expenses, uncollectibles and variable overhead expenses. The expense module then displays the investments and associated expenses for each unbundled network element for each wire center or CBG.

Data for the expense module are obtained from the distribution, feeder, and switching and interoffice modules, as well ARMIS. Results may be displayed by density zone, by individual wire center, or by CBG. Listed below are additional details describing the calculations and assumptions used in this module:

- While certain costs are closely linked to the number of lines provided by the incumbent local exchange company, other categories of operating expenses are related more closely to the levels of their related investments. The expense module develops factors for numerous expense categories and applies these factors both against investment levels and demand quantities generated by previous modules.
- Capital carrying costs are estimated using standard financial techniques. A weighted average cost of capital is derived from a debt/equity ratio, cost of debt, and cost of equity. Equity is subject to federal, state, and local income tax, which necessitates an increase in pre-tax return dollars, so after tax return is equal to the assumed cost of capital. All rates are user definable.
- The Hatfield Model assumes straight-line depreciation and calculates return on investment, tax gross-up and depreciation expenses annually on the mid-year value of the investment. Return is earned only on net capital, but because depreciation results in a declining value of plant in each year, the return amount declines over the service life of the plant. To ensure that a meaningful long run capital carrying cost is calculated, the return amount is levelized over the assumed life of the investment using net present value factors.
- Operating expenses are comprised of network related and non-network related. Network related expenses include the cost of operating and maintaining the network, while non-network expenses include customer operations and variable overhead. Expense categories in USOA are Plant Specific Operations Expense, Plant Non-Specific Operations Expense, Customer Operations Expense, and Corporate Operations Expense. Local telephone companies report historical expense information for each of these major categories through the FCC's ARMIS program. These data are then used to estimate forward looking expenses.
- Plant specific operations and non-plant specific operations are the two major network categories under which expenses are reported. Expense ratios are calculated based on capital investments. These ratios are applied to the investments developed from the distribution, feeder, and switching and interoffice modules to derive associated operating expense amounts. Other expenses vary more directly with the number of lines rather than capital investment. Expenses for these elements are calculated in proportion to the number of access lines supported.
- The expense module estimates direct network-related expenses for all of the unbundled network elements. Operating expenses are added to the annual capital carrying cost to determine the total expenses associated with each unbundled network element. The network related expenses include network support, central

office switching, central office transmission, cable and wire, and network operations.

- Total network operations expense is strongly line-dependent. The Hatfield Model computes the expense as a per-line additive value based on the reported total network operations expense divided by the number of access lines and deducting 50 percent of the result to produce a forward looking estimate.

- Non-network related expenses are assigned to each line density range, CBG, or wire center based on the proportion of direct expenses for that unit of analysis to total expenses in each category. Non-network related expenses include variable support, which varies by size of firm and are not pure overhead; general support equipment, which calculates investment for furniture, office equipment, general purpose computers, buildings, motor vehicles, garage work equipment, and other work equipment. Ratios of investments in the preceding categories to total investment are multiplied by the estimated network investment obtained from the model to produce the investment in general support equipment. The recurring costs of these items are then calculated from the investments in the same fashion as the recurring costs for other network components. A portion of general support costs is assigned to customer operations and corporate operations according to the proportion of operating expenses in these categories to total operating expense reported in the ARMIS data. The remainder of the costs is then assigned directly to unbundled network elements.
- Revenues are used to calculate the uncollectibles factor. The factor is a ratio of uncollectibles expense to adjusted net revenue. This module computes both retail and wholesale uncollectibles factors, with the retail factor applied to basic local telephone service monthly costs and the wholesale factor used in the calculation of unbundled network element costs.

Criticisms of the Hatfield Model

The Hatfield Model is a good attempt at modeling the TELRIC costs of forward looking telephone network. However, after reviewing the model, inputs, and methodology Staff found several concerns that suggest the Hatfield Model is not yet ready to develop permanent prices for unbundled telephone network elements in Missouri. These concerns are based on the Hatfield Model being a work in progress, weaknesses in the data, assumptions about Census Block Groups, how the network is built, assumptions about switching and wire centers, certain area specific variables cannot be geographically deaveraged, and that the model does not account for growth. Many of these concerns can be fixed through geocoding individual households and businesses. These concerns are discussed below:

The Hatfield Model is a work in progress:

- Several revisions have taken place for the Hatfield Model since 1996. Many of these changes were to make the model more efficient and user friendly. However the model is still being improved and needs more improvement. As with all computer programs there are bugs to be fixed. Many of the recent changes were made to fix bugs in the programming. In fact, Staff received updates on May 16, 1997 that fixed several bugs. The following modifications were recently made to The Hatfield Model:

- Modifications were made to the distribution and expense modules and to the data.
- The modifications to the distribution module includes correction of calculations for ratios, investment in cable and structure, low density DLCs, and backbone distribution tapering.
- Modifications to the expense module includes correction of the assignment of expenses to network support and investment and expenses for general support.
- Modifications to the data include increasing the accuracy of the data in general, correcting household and business data, and geocoding CBGs to 97.2 percent of wire centers.

Data criticisms:

- Even though the population data are publicly available, it is based on 1990 Census data. The CBGs were created from this data in 1995. Since seven years have passed since the last Census, the accuracy of the data may have diminished.
- The data were obtained from several sources: Census, Dun and Bradstreet, Donnelly Marketing, Claritas, and Bellcore. The data were then merged together to create the database. Many of the variables are based on national averages and knowledge of the Hatfield Model designers. Therefore, the data may not be appropriate for determining the cost of unbundled network elements in Missouri.
- CBGs are based on population size only and do not include the area covered by the CBG.
- The Hatfield Model assumes an entire CBG is served by one wire center. If more than one wire center serves a CBG, the wire center serving the majority of customers in the CBG is the one selected for calculations. In reality, several wire centers may serve a CBG.
- If company specific data were used, residences and businesses were geocoded into the database, and state specific prices, were used for network components, the Hatfield Model would be a more viable model.

Assumptions about Census Block Groups:

- The Hatfield Model bases all network designs on square CBGs. In reality, networks are not all square.
- The Hatfield Model divides CBGs into four quadrants and assumes that the population is evenly distributed in the CBG. If more than 50 percent of the CBG is empty, consumers occupy only two diagonally opposed quadrants of a CBG. Otherwise, consumers occupy all four quadrants. In reality, consumers are scattered sometimes evenly, sometimes unevenly throughout an area.

- Creates a theoretical network based on CBGs. The CBGs are geocoded into the Hatfield Model database based on latitude and longitude. From these data, The Hatfield Model creates a theoretical network based on assumptions concerning the size and shapes of the CBGs. This network may not match what has been built in reality. The model will place switches and cable based on the CBGs, not based on where consumers actually reside. Therefore, the network the Hatfield Model creates is not an accurate representation of reality. If residence and business locations were geocoded into the Hatfield Model database, the network that is created would be more realistic. Geocoding individual dwellings and business would also alleviate concerns related to population distribution and eliminate the need to rely on CBG data.

Deaveraging:

- The Hatfield Model is limited in the number of density zones for which rates are determined. HM allows 9 zones only, which cannot be varied to match incumbent LEC's rate zones.
- The Hatfield Model does not geographically deaverage terrain, rock depth, soil hardness, town, or lot size. The fact that these values are not deaveraged, leads to the idea that the output is limited to company-wide averages.

Switching and Transport:

- The switching investment curve is much lower compared to SWBT. The Hatfield Model assumes that investment per line, depending upon number of lines, that the investment is between $173/line for less than 2,000 lines and $80/line for 80,000 lines or greater. SWBT contends that switching investment per line is between $150 and $250 per line. Modifying the switch investment curve requires significant programming changes and even renaming the model.
- HM assumes all SONET rings are OC48. SONET rings can also be OC3 , OC12 and OC192 (being developed).
- The model assumes 100 percent integrated DLC. This assumption is not realistic with collocation.

- The network the Hatfield Model constructs is assumed to be built all at once. This is not reasonable because telephone companies construct networks pieces at a time. Even on a long run basis, where an entire new network can be built, the new network will not be built all a once. Furthermore, the Hatfield Model does not provide costs for all elements needed in a network. For example, costs for trunks and ISDN services are not determined.

- Even though the Hatfield Model is forward looking, it does not account for growth. HM assumes the minimum facilities to meet current demand will be built. This assumption has the advantage of placing lower cost facilities, but does not account for future demand.

Conclusion

In summary, the Hatfield is a personal computer based program that develops a local exchange telephone network based on user inputs, demographic, and geographic data. The Hatfield Model builds a network based on current demand and determines costs associated with several unbundled network elements. Although the Hatfield Model attempts to make comprehensive estimates of the costs associated with a network, Staff has several concerns that suggest the Hatfield is not the correct cost-determining model for Missouri. These concerns are based on the Hatfield Model being a work in progress, weaknesses in the data, assumptions about Census Block Groups, how the network is built, assumptions about switching and wire centers, certain area specific variables cannot be geographically deaveraged, and that the model does not account for growth. When these problems are corrected, the Hatfield Model may become a stronger model for estimating TELRIC and providing permanent prices in Missouri.

Missouri / Southwestern Bell